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Poster paper

Upgrading beamline performance: ultra stable mirror developments at ESRF

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The ESRF has now started its upgrade programme. It has become evident from the start that upgrading beamline performance implies upgrading component performance. Beam stability is seen as a key requirement for many of the proposed beamlines, but the source of (in)stabilities can be manyfold. However, one identified source is white beam mirror, and therefore, ESRF has recently invested significant amount of engineering effort to improve white beam mirror performance. The motivation for having ‘ultra stable mirrors’ at the upgrade beamline ID24 Dispersive Exafs is analysed. The design solutions for positioning, cooling and supporting the white beam mirrors for this project are presented.

1. The requirements

The emergence of ‘double’ beamlines, either canted or in multiplexed configuration, means that mirrors are often used to separate beams going to different end stations. ID24 is such a case where two single-bounce mirrors are used to deflect the white beam and subsequent pink beam to end stations positioned at 24 and 29 m, respectively. These long lever arms mean that the angular stability of each mirror is critical to the overall stability of the beam at the sample position. A 10 % stability of the desired beam size of 100 μm before the final focusing mirror leads to an angular stability requirement of approximately 0.4 μrad . This applies to both the thermal drift regime >30 s and the vibration regimes up to 200 Hz.

2. Vertically deflecting white beam mirror

As previously reported by Mairs and Mathon (2009), the vertically deflecting mirror presently installed on ID24, which is based on three external vertical actuators manipulating the mirror via bellows, exhibits both thermal drifts and relatively poor vibration performance transmitted from the floor and cooling circuits. As such the new equivalent mirror in the upgraded ID24 was used as a basis for producing new generic designs for mirrors at ESRF.

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Positioning of this flat mirror system has been analysed with the view of minimizing the motorized degrees of freedom to improve vibration performance and where possible the motions are 'locked' once it has been completed (figure 1).

A compromise has been made for the translation between the different coatings on the mirror. This is a movement that is performed maybe once a week and the required precision of ± 0.25 mm can be achieved with V friction rails. This solution is adopted as the top movable granite block can subsequently be clamped using a motorized 'airlock' height adjuster and spring washers.

The movement that requires state-of-the-art precision adjustment is the pitch of the mirror, a 100 nrad resolution is required while maintaining high rigidity and stability. The actuation of the mirror via leak-tight edge-welded bellows has been adopted. To achieve the rigidity and precision requirements a new ESRF generic vertical jack has been designed. This features an over-constrained mechanical assembly of two Schneeberger NK9-210 cross roller bearing tables linked together and driven by a backlash-free satellite roller lead screw (figure 2).

In order to achieve the necessary resolution the lead screw is driven using a Micos PRS110 rotary table. This choice of over-constrained bearings requires very tight machining tolerances and also a critical adjustment and assembly stage. The overall vertical jack assembly has been designed to minimize thermal drifts by cooling the motor and ensuring that air currents do not change the temperature of the mechanics. The necessary rotations and translations for the fine adjustment of the pitch of the mirror and other thermal differential expansions in the system are taken up by means of flexural hinges of the maximum reasonable rigidity.

Thermal stability is critical for white-beam mirrors. The first mirror in ID24 has a total incident power of 1200 W of which 750 W is not transmitted. It is estimated that about 650 W is absorbed and 100 W scattered around the vacuum chamber

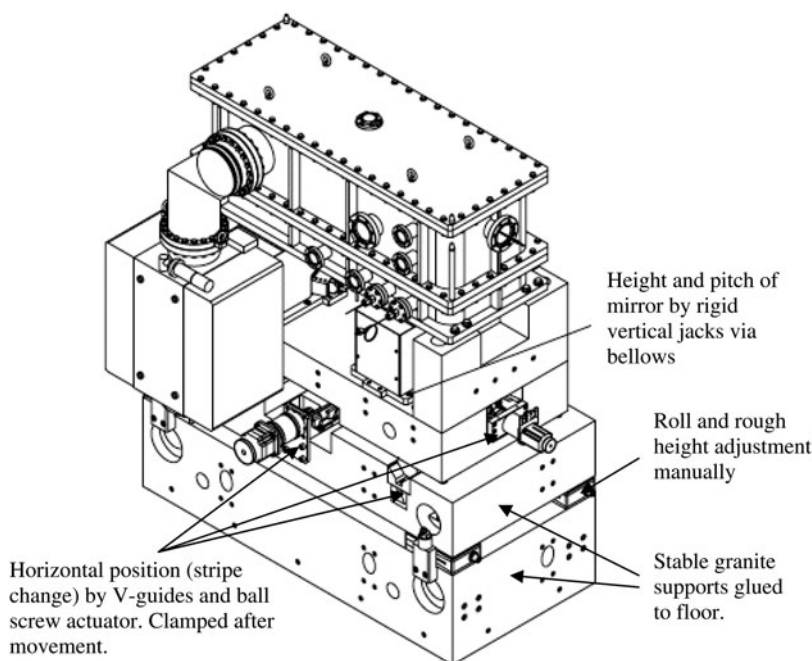


FIGURE 1. Vacuum and support system for a flat mirror in bender.

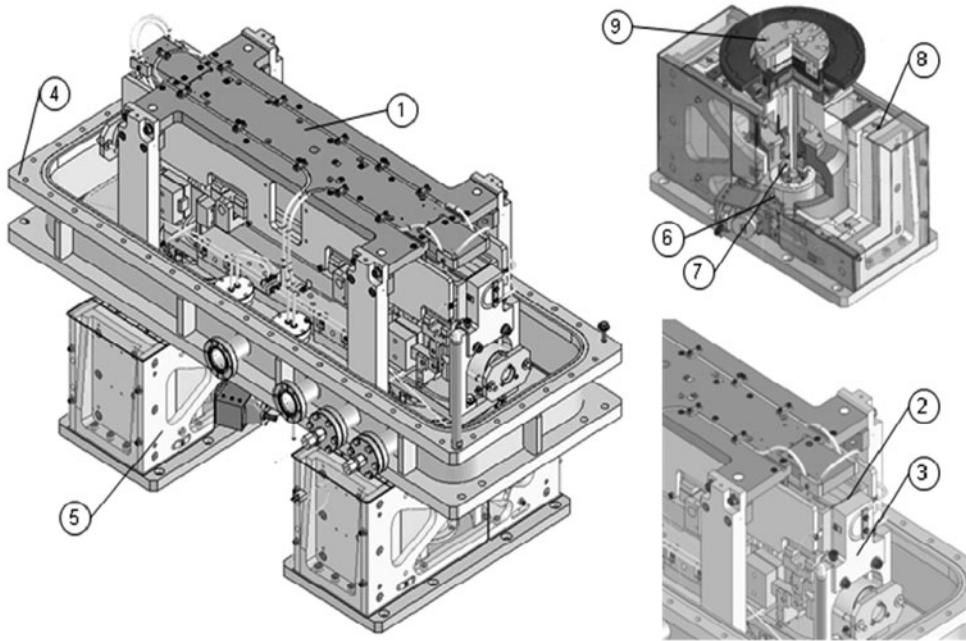


FIGURE 2. Internal mechanics and vertical adjustment of mirror: 1. cooled Compton shield; 2. mirror in Zeiss bender; 3. cooled protection absorber; 4. split vacuum chamber for access; 5. ESRF generic vertical jack; 6. Micos rotary table; 7. satellite roller lead screw; 8. Schneeberger NKL9 table; 9. flexor.

by Compton scattering. Both the absorbed power and the scattered power can lead to thermal drifts in the mechanics of the mirror positioning system. Particular care has been taken to ensure that scattered photons do not impinge on non-cooled surfaces by means of shields and secondary cooling circuits.

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MAIRS, T. R. & MATHON, O. 2009 'Beam stability: benefits on concentrating on basics'. In *Conference Proceedings SRI*, American Institute of Physics (to be published).